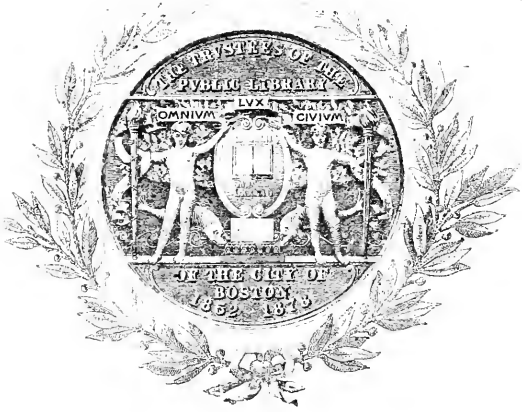
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REMARKS

ON

SUPPLYING THE CITY OF BOSTON

WITH

PURE WATER.

BY JOHN H. WILKINS.

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REMARKS.

In the recent canvass for the election of city officers, I was, in several papers, charged by name, in connection with other candidates for Aldermen, with being opposed to supplying the city with water. This circumstance must be my apology for publishing the following remarks. They will, I trust, not only show that I was misrepresented, but will serve also to show my fellow-citizens how far I deem that public opinion has been misled, and the public interest been overlooked, in this water-movement. Whether the evil can be remedied, must depend upon the good judgment and sound discretion of the City Government.

To the subject of bringing water into the city, I have, for more than twenty years, given more or less attention. I have read with care all the several reports, made by the different commissioners, appointed by the city, to investigate the subject. I have endeavored to study their *facts*, and to form opinions for myself; supposing that any citizen of common intelligence, and a moderate acquaintance with the scientific principles involved, could form, perhaps, as correct a judgment upon the matter as the commissioners themselves. Inquiring into the subject in this spirit, I have come to some definite conclusions, not altogether in accordance with the opinions of the commissioners.

I am entirely satisfied that the city of Boston ought to have a copious supply of good water from a foreign source; that on the whole this supply should be introduced by the city government; and I am inclined to take one step further, a step not proposed to be taken by those who have been most zealous in pressing forward the project, namely, *to distribute the water*, FOR DOMESTIC PURPOSES, *free from charge*. This plan, I am aware, is novel, and liable to objections; as also is every other. Yet the arguments in its favor are so numerous, and to my mind so weighty, that I do not see how they can be fairly met. But as this point is not now a matter of public interest, I shall dwell no further upon it than to express regret, that the citizens have seemed, by their late vote, to have committed the city to a different plan.*

In looking for a supply of water from abroad, every one, I suppose, deems it expedient to investigate the *nearest* source that can supply the want. Proximity is important in two respects; first, in regard to cost, and second, in regard to liability to accidents or interruptions in the means of conveyance. It might be difficult to say in which respect it was most important that the supply should be *near*. I take it there is no example, certainly no prominent one, where a city in modern times, has gone further than was strictly *necessary* in order to obtain a supply. New York has selected a source at greater distance than any other city where the object was merely a supply of water; but New York selected the *nearest* source that was deemed adequate to supply the demand, without crossing the Hudson.

On this principle where should the citizens of Boston naturally look for water? Charles River pours a flood at our doors — a flood of excellent water. Why go over or beyond

* If any reader desire to know my views more fully on this subject, and the reasons for them, he may find them in the *Boston Courier*, of September 24th and 25th, 1844. Should this point become one of public interest, I shall probably have some views to present upon it for public consideration.

it? Charles River is just as naturally the source of supply for Boston, as the Schuylkill is for Philadelphia. What should we have thought, if Philadelphia had gone over and beyond that river for a supply? Certainly that she was governed by unwise counsels. And if we go over and beyond Charles River for our supply, without good and substantial reasons, — reasons much better and more substantial than any that have occurred to me, or than I have seen stated by others — the city of Boston will, I think, expose herself to a like charge.

I have stated that I have carefully studied the reports of *all* the commissioners who have made communications to the city government on this subject. But the one which is most elaborate and full of details, is that made in 1837, by Messrs. Treadwell, Hale and Baldwin, and which has recently been reprinted and distributed to the citizens. It is understood that all these gentlemen agreed in regard to the statements and estimates contained in this report; they differed only in the inferences to be deduced from them. From an attentive examination of this report, in connexion with others, I think it clear that the proper source of supply for the city *is Charles River, at the lower dam in Watertown.* It seems clear, 1st, that the water is better than that of Long Pond; 2d, that it is vastly more abundant; and 3d, that it can be introduced into the city at greatly less expense than that of the Long Pond. Now if these three propositions can be maintained, and the citizens can be made reasonably certain of their truth, where and what is the inducement to go to Long Pond? Let us look at the facts and estimates which go to establish these propositions.

1. *That the water of Charles River is better than that of Long Pond.* To establish this point, let us look at the accounts of both waters furnished by two different gentlemen who analysed them, viz., Mr. Hayes of Roxbury, and Dr. Jackson, of this city, and inserted page 9 of the report just

referred to. Mr. Hayes says of Charles River water, "nearly colorless, no perceptible odor, *is more brisk and sparkling than either of the other specimens;*" embracing, with others, that from Long Pond. Of that of Long Pond he says, "it resembles No. 4 (Charles River) in physical properties." Now I submit to the decision of good judges of water, if the fair inference from this description be not in favor of Charles River water? But what says Dr. Jackson? Of the water of Charles River he says, "clear, transparent and colorless. No *animalculi*," or little animals. Of the water of Long Pond he says, "it has a slight tint of brown, and contains a few flocculi *and animalculi*," or little animals. This analysis by Dr. Jackson, is taken from Mr. Loammi Baldwin's Report, and was made for him in 1834. By turning to that report, a little more light is shed upon these animalculi, especially those of Spot Pond, which are probably similar to those of Long Pond. Of these Dr. Jackson says, they are "*oval-shaped*, with antennæ (little horns, or feelers,) and a tail of a minute size," and that they "move with great velocity, by starts, through the liquid." Besides the fact here stated, that Long Pond water has animalculi and Charles River has not, I suppose it to be a general rule, that River water does not have them, and that Pond water is subject to have them, and generally does have them. Dr. Lee, of New York, in an essay upon Croton water, says, "The aquatic animals, which have from time to time been exhibited in this city, by means of the solar microscope, are collected in stagnant pools, *and are never found in river or well water.*"* Here, then, we have ground to infer, that not only the specimen in hand of Charles River water had no animalculi, but that other specimens are not liable to have any; and that not only the specimen in hand of Long Pond water did have them, but that all specimens are liable to have them. Now I submit to all judges of water, whether a glass without animalculi, "clear,

* "River" and "well" water probably mean *running* and *spring* water.

transparent, and colorless," "brisk and sparkling," be not better water than a glass having "a slight tint of brown," with animalculi, "oval-shaped, with antennæ and a tail," though "of a minute size," moving "with great velocity, by starts, through the liquid?" Besides the verdict which common sense and our common senses must pronounce upon this matter, we have also the doctor's decision. This same Dr. Jackson analysed several specimens of water for Mr. Eddy, in 1836, (though not those of Long Pond, or Charles River,) and of one of them he says, "*it will doubtless be preferred on account of the absence of animalculi.*" This he put in italics, as if a matter of marked importance.*

Now unless something more, and something different, is to be said about these waters, than what these gentlemen have said about them, I can entertain no doubt but that all, or nearly all, will agree that those of Charles River are the best.

But before I proceed to the second proposition, I will notice the common objection made to Charles River water, that it is rendered impure by the filth and impure substances, received from the factories upon its banks, and especially from the large manufacturing establishments at Waltham. In answer to this objection, I would remark, that all such substances only *mix* with water, and do not become *incorporated* with it; consequently *running* water soon clears itself of all such foreign substances. Hence the fact, demonstrated by the experiments above referred to, that no trace of any of these foreign ingredients, rendering the water impure, were detected in the Charles River water at Watertown. We are hence authorized to consider this objection as purely one of the imagination.

But as the imagination is really a part of a man, and sometimes needs quieting, I would propose to go to the expense of digging a canal, or even of laying in masonry a

* See Note A.

common sewer, from the Waltham factories to the Watertown dam, so that all the impurities, derived from those establishments and all below them, should be discharged below the point at which water would be taken for the city. The distance is but about 3 miles, and the expense would be but a trifle.

There are no other manufactories nearer than nine or ten miles; and it certainly seems like a work of supererogation to devise means of removing impurities from which the water of the river must clear itself long before it would reach Watertown — although such means might be easily and cheaply devised, if found expedient.

Impurities in water are generally either such as will settle to the bottom, be thrown to the shores, or escape into the air. Now Charles River appears to me to be remarkably favorable in many of its circumstances for cleansing itself of impurities. For it is well known to have extensive reaches, where the current is very slow, giving opportunity for every thing to subside to the bottom, the specific gravity of which is greater than that of the water; while the occasional occurrence of dams, falls, or rapids, affords all the advantages that can be derived from agitation in throwing matters to the shore, or causing them to escape into the air. Alternation of rest and motion, is just what is necessary to purify water.

It must be borne in mind, that these comparisons of the waters of Charles River and Long Pond are made while these bodies of water are in their natural beds or channels. What the quality of the Long Pond water will be when the dam shall be raised 5½ feet, and the surface thrown over new meadows and peat bogs, nobody can tell. It is a fact well ascertained, that such extension of flowage sometimes renders the water unfit for use, and even imparts to it qualities deleterious to health — and who can give us assurance that such may not be the result here? No prudent individual would run the hazard of such an experiment; and why should

the city of Boston be less prudent than an individual in a matter of such vital importance?

I come now to the second proposition, namely, *that the water of Charles River is much more abundant than that of Long Pond.* By the report of the commissioners of 1844, just published, the extent to which Long Pond can be relied on by the proposed plan of damming, is 12 cubic feet per second; whereas Charles River in the dryest seasons yields from 40 to 60 cubic feet per second. See Report, 1837, page 67. The former *may* yield an average of 7 millions gallons per day; the latter will *certainly* yield from 25 to 30 millions per day in the dry months, and an incalculable quantity in the wet ones.

Now I do not know that much importance should be attached to the fact of the supply of Charles River being so much greater than that of Long Pond, IF it were a *clear case* that Long Pond would yield an average of 7 millions gallons per day; for I can hardly suppose a greater quantity will be wanted. But in undertaking a work of this character, I should think it unwise to select a source that would yield less than this quantity; or indeed a source that would not *fully* and *certainly* come up to this quantity. And I do think there is serious ground of doubt whether, by all the means proposed, Long Pond can be made to deliver in Boston that quantity daily. The commissioners, (or a majority), with a strong bias for Long Pond, and with a disposition to put its capacity in a favorable light, do not think it can be made to yield more. "The maximum supply, (say they, page 27,) which, in their opinion, can be held in reserve by artificial means, for regular and permanent use, is computed not far to exceed 12 feet per second." If then this be the computed maximum of supply, and if this be necessary in order to deliver 7 millions gallons per day, is it safe to rely upon obtaining that quantity, computed, as it has been, in haste, and from few and imperfect opportunities of observation and experiment? Is it not al-

ways safer to rely upon a *medium*, than a *maximum*, estimate? How much more wise would it be, and how much more safe, to resort at once to a source incontestably inexhaustible for the purposes contemplated?

The third proposition is, that *the water of Charles River can be introduced into the city at greatly less expense than that of Long Pond.*

Whether the waters come from Long Pond or from Charles River, they are estimated to be delivered at a reservoir on Corey's Hill, in Brookline. In the comparisons I shall make of the two schemes, I shall, therefore, *for the present*, lay out of view all the estimates for taking the water from this reservoir, and distributing it through the city; for it is obvious that this expense will be the same on either plan. I shall proceed, therefore, to compare the cost of delivering a supply into this reservoir from Charles River and from Long Pond.

By reference to the Report of 1837, pages 19 and 68, will be found the estimates for bringing water in iron pipes from Charles River, at Watertown, to Corey's Hill, with water rights, and two steam engines for elevating the same. The items, making the cost, amount to $252,806. But this estimate allows nothing for working and repairs of the engines; and to the cost of the work should be added such a sum, as, at five per cent. interest, would yield an amount equal to the annual expense of working and repairing the engines. This expense is estimated on page 72, at $11,808; to raise which, at five per cent. requires $236,160. (See page 21.)

To the estimated cost of the works, .	$252,806
Should be added for working and repairing engines, ...	236,160
Making a total of . . .	$488,966

But this estimate was made seven years ago, and it will certainly bear co siderable reduction. It has b en stated that the plan contemplates bringing the water in iron pipes;

and these pipes constitute the most costly item of expense. The commissioners estimated them to cost 3½ cents per pound. (See page 69). But in the report of commissioners of 1844, recently made, (page 23), iron for pipes is estimated at only 2½ cents per pound; and the commissioners say this "is higher than it would be necessary to pay, if the pipes were to be contracted for at the present time."

So the lead for filling the joints was taken in 1837, at 6½ cents per pound; and in 1844, at 4 cents per pound; which is a reduction of near forty per cent. The quantity of the iron and the lead is not given — but the cost of both and of laying is $144,918. Now if we take 2-7ths of this amount, the rate of reduction in the price of iron, (leaving the short reduction in lead to balance any too great reduction in expense of laying), and we have the sum that can be saved in this item, $41,405.

Again, for fuel to supply the engines, the sum of $5,070 is allowed annually; (see page 72); proposing to use bituminous coal at $10 per chaldron. Now for the general reduction which has since taken place in fuel, for the substitution of anthracite for bituminous coal, and for the improved methods of generating steam since adopted, it would be a very moderate estimate to allow 20 per cent. or $1000 per annum, to be saved — thus reducing the cost of fuel to $4,070 per annum. To cover this sum of $1000 annual expense, now supposed to be saved, there has been added in the estimate $20,000, viz. the sum, that at 5 per cent. would yield $1000, which sum is $20,000. Therefore $20,000 should be deducted on this account.

Nor should reduction stop here. The two engines are heavy items in the cost, (say $70,000,) and are constructed almost entirely of iron. It is not obvious, therefore, why a similar reduction on the iron used for them should not be made as upon that for the pipes There can be no doubt, too, that in the last seven years important improvements have been

made in constructing engines; so that from both considerations, it appears to be a moderate assumption that engines, of the capacity estimated, can be constructed 10 per cent. cheaper now than in 1837 — thus making a saving of $7000.

From the estimated cost, ...		$488,966
Take for saving in pipe, &c. .	41,405	
" " " in fuel, . .	20,000	
" " " engines, . .	7,000	68,405
		$420,561
Add for contingencies, 12 per cent. . .		50,467
We have the cost		$471,028

estimated as nearly as practicable at present prices.

The contingencies are estimated at 10 per cent. by both the commissioners of 1837 and 1844; but Mr. Loammi Baldwin, in his report of 1834, allowed about 12 per cent. As the uniform lesson of experience is that each is too small, I have retained the larger.

Now let us look at the estimated cost of bringing water from Long Pond. By reference to the estimates on the two last pages of the Report of 1844, just published, and by omitting therefrom the items relating to the cost of the reservoir and the distribution of the water, we shall find the cost of delivery at the reservoir to be $809,776. As to the prices of the various materials, they are probably correctly taken in making up the estimates. But in this connection there is one item which ought not to be overlooked. I refer to the estimated damages to water and land rights, particularly the former. However prudent and praiseworthy it may have been in the commissioners to put a low estimate on this item, in order to avoid holding out temptations to those interested; still, no citizen, in making up his judgment upon the measure, ought to allow himself to be misled by it. What would be

a fair equivalent for damages of this character, would be a most difficult and complicated question to settle, even were parties on all hands disposed to be reasonable. But being a voluntary aggressor, the city could hardly expect to settle with those whose property and rights were invaded, upon terms entirely fair and equitable. But even for equitable compensation, I cannot but regard the estimate as quite too low; and for such compensation as there is every reason to suppose will be claimed, *and will be obtained too*, it is, I think, greatly inadequate. I do not, however, propose to add to the estimate, any thing on this account; I only wish it to be noticed, that one of its elements is of an extremely questionable character, to say the least of it.

Add to estimate, ...	$809,776
For contingencies, 12 per cent. . .	97,173
Total,	$906,949

Here then we have the cost of the Long Pond water, delivered at Corey's Hill, estimated at, 906,949

That from Charles River at . . . 471,028

Difference, $435,921

The one costing nearly double the other, and the difference, at 5 per cent. yielding or requiring, as the same shall be saved or expended, the annual sum of $21,795; — a sum sufficient to furnish fuel for five additional engines.

And it is well worth remembering, in weighing these facts, that the Long Pond estimate was made by commissioners (a majority at least) supposed to be strongly in favor of that source, and of course inclined to put every thing in as favorable light and at as low an estimate as the circumstances would allow; — while the Charles River estimate was made by commissioners none of whom were in favor of that source, and of course may be expected to have put things quite as high as necessary, and to have protected themselves from

the hazard of misleading public opinion, by erring on the safe side.

Now for what is it proposed to pay this sum of $436,000, or an annual sum of near $22,000? What advantage does the city expect to derive from it? What is the real difference of the works? The Long Pond works are intended to be capable of delivering 7 millions gallons at the reservoir daily. The engines at Charles River are calculated to be able to deliver each 3 millions. In the provision made for working, it is, however, calculated, that only one will at present be worked, and that only 20 hours per day, delivering 2½ millions daily into the reservoir. And whenever more than this shall be required, further provision must be made for expenses.

No one supposes there can be any value to the water in the reservoir, whether derived from one source or the other, and whether delivered 7 millions per day, or 2½ millions per day, except for city purposes. Hence it is obvious, that there is no advantage in having 7 millions gallons delivered daily, (the provision made by one scheme,) over having 2½ millions, (the provision made by the other,) unless or until more than 2½ millions are required for city use. Nor is there any advantage in the larger scheme over the smaller, if the interest on the difference in cost will enable the smaller to yield a further supply as it is wanted, till it shall equal that of the larger.

Of the quantity of water which will be required for the use of the city, different opinions will be formed. It is to be feared, however, that very extravagant ideas are prevalent on this subject, and that the consumption is in general greatly over-estimated; and that it is important, in forming a fair and just judgment in regard to the best source, to correct the judgment of the public on this matter of consumption.

Certain it is, that no other guide than experience can be

safely relied upon; and all experience teaches the same lesson, viz., that the habit of using aqueduct water for domestic purposes, in large cities, is formed slowly. This is true even of cities where it is difficult to obtain any other; — how much more then will it be true of Boston, where all the requisite apparatus for obtaining it elsewhere, from wells and cisterns, is in good order, and in actual operation?

For more than two hundred years the inhabitants of London have been supplied with water, from water-works — and the consumption has at length reached about 28 gallons per day for each inhabitant. This embraces all the water used for all purposes, such as manufactories, breweries, baths, stables, washing streets, &c., furnished by the water-works. Philadelphia has received a supply of water from the Schuylkill for about thirty years; and in the *city proper* the consumption for all purposes is supposed to be about the same *per caput* as in London. But if the consumption in the *whole water district* of the city and suburbs be averaged upon the whole population of that district, the amount will undoubtedly fall far below 28 gallons to each individual. Now if it has taken London 200 years to come up to a consumption of 28 gallons for each inhabitant; and if it has taken Philadelphia *city* 30 years to arrive at the same comparative consumption, while the whole water district, taken together, remains far below it; we are able to judge something (at least negatively) of the time it will take for Boston, now, as always, tolerably well supplied by other means, to come to a like proportional consumption. From the examples of these cities, and from the condition of Boston, it is difficult to see any grounds for the most sanguine to expect such a result here in less than twenty-five years — the more phlegmatic calculator would require fifty, or perhaps one hundred years. The New York water-works have not been in operation long enough to afford any safe data in the present calculation; but so far as they give any indications, they certainly must be admitted to be any thing but encouraging.

We have, however, an example at our own doors, to which it probably will be most prudent to look for data in the present estimate. The water of Jamaica Pond has been running for fifty years by the doors of the dwellers in the southern section of the city, and what is the result? Up to 1838, (44 years say), only *one* dwelling-house in *four* took the water. (See Mr. Sargeant's Letter, printed among city documents in 1838). On the *old streets*, not more than one in three now take it; though in the new streets on South Cove and the neck lands, nearly all the houses take it —making probably an average of about one-half the houses in the range of delivery.

Now if any one supposes that the *old streets* of the city in other portions will more readily, and much more generally, take the water, which the city will introduce, than the inhabitants on the old streets of the South portion, have the waters of the Boston Aqueduct Company, he certainly may be called upon with propriety to give reasons for his opinion; and good reasons for such an opinion will not readily occur. Certainly none will result from a comparison of the waters; for the city, go where it may, cannot hope for better water than that of Jamaica Pond.* Nor can any result from a general necessity; for there is not a particle of evidence that the old streets of the North, East, and West portions of the city are not naturally as easily and as abundantly supplied as the South. It would be extremely difficult to find any reason, except that possibly the city will supply it cheaper. But this is at best a very unsafe element to calculate upon, even if it were certain; for people long accustomed to get along, and get along well, without a foreign supply, will not at once, and by impulse, change their habits, and resort to a foreign supply, *merely* because it is cheap. Cheap as it may be, it will be cheaper to do without it. But whether the fact

* This Pond, fed entirely by springs, and having a clear gravelly bed and shores, yields uncommonly good water.

will ever be as the hypothesis supposes, is entirely doubtful. Whether the Water Commissioners will make the city water rents lower or higher than those of the Aqueduct Company is entirely unknown, and of course not to be calculated upon.

If, then, we take the experience of the Boston Aqueduct Company for fifty years as a guide, the period must be very far distant when the consumption of foreign water will equal 28 gallons to each inhabitant; for the supply of this company does not equal that amount to those who take it, — very much less to the whole number of those living in the range of its delivery.

There does not appear, then, to be any grounds in the experience of other cities, or our own, to expect that the consumption of water in this city for all purposes, will equal 28 gallons per head in less than 30 years. Indeed this term must be deemed very short — far shorter than experience justifies. Still, for the present argument let it be assumed.

By the time the contemplated works will be finished, the city will probably contain 120,000 inhabitants. It will be deemed a very liberal estimate, to suppose the works to go into operation, with a demand for supply equal to 10 gallons for each inhabitant. This would require 1,200,000 gallons daily, or what one of the engines would deliver into the reservoir in little less than 10 hours, or less than half the time provided for working. Let us suppose that the population increases in ten years to 160,000, and that the consumption of water goes up to an average of 16 gallons daily to each inhabitant, this will require 2,560,000 gallons, — still less than the daily work of one engine, though a trifle more than the 20 hours' work, for which provision is made in the estimate. During this ten years, beginning with 120,000 inhabitants and with 10 gallons per day, and ending with 160,000 inhabitants and 16 gallons per day, the average daily delivery of the engine for the whole time will be equal to 13 gallons per day for 140,000 inhabitants, which is

1,820,000 gallons. But as there is made in the estimate allowance for delivering daily 2,500,000 gallons, and only 1,820,000 is required, there will be saved something more than $\frac{1}{4}$ part of the fuel provided, for the whole time.

Now let us proceed five years further, supposing the inhabitants to increase to 180,000, and the demand for water to go up to 19 gallons per day for each. At the end of this period, the demand will be equal to 3,420,000 gallons per day; and the *average* daily demand during the five years be equal to 2,975,000 gallons, — still less than the capacity of one engine to perform, though in the latter part of the time it will require both engines to be at work part of each day. But the fuel, &c., saved in the first ten years will constitute a reserve fund amply sufficient to cover all expense of over work in these five years.

Here, then, we have a clear period of fifteen years, during which the contemplated works at Charles River will require no enlargement; and the quantity they will deliver will just as fully supply the city as the larger work from Long Pond. Here then, we have the clear saving of the interest of $436,000, for fifteen years at least. Now let us see what this amounts to at compound interest, at five per cent. On going through a calculation, this sum of $436,000 becomes, at the end of fifteen years, at five per cent., $906,411; from this sum subtract the principal, $436,000, and we find a clear saving to the city in that period of $470,411; a sum almost exactly the original cost of the work. So that if at the end of that period the works should become in all their parts utterly useless, still the city would be no loser, as she will have saved enough to reconstruct them.

But instead of the works becoming useless in that time, they will just get into working order. The second engine will hardly have preserved itself from rust. But to guard against accidents, it will then probably be expedient to erect a third engine, of like capacity with the others, at an expense

probably then of about $25,000, and make provision for working it; and sometime within thirty years it may possibly be expedient to lay another main from the source to the reservoir, at a cost of $100,000, and then will end all expense, till more water is wanted than Long Pond could possibly supply. And the contingency of this necessity may be entirely avoided, by making the pipe a little larger at the outset.

I can entertain no doubt that every intelligent reader, who will really give attention to these estimates, will agree with me that they are liberal — very liberal; — that there is no human probability that the city can increase as fast as I have supposed, or that the demand for increased consumption of water can even approximate to my supposition, if water rents be paid.

A remark occurs to be made here, which goes to strengthen the views here expressed. It is this; that the city is not going to have all the water custom; that is, is not going to furnish all the supply. The Boston aqueduct company is in the field; and, while water-rents are assessed, they will put their rents as low as the city does, and will, *beyond all question*, retain all the customers they have the means of supplying. And, if water-rents should be abandoned, equity would seem to require, and expediency to recommend, the city to purchase their works and rights at some price, and continue to use them to the extent that they can give a supply. In either case, a large portion of the city is relieved from a reliance on the contemplated water-works, and, of course, the demand upon them, both now and prospectively, is so far reduced.

So far, then, as the city supply is concerned, it seems that the larger work of bringing water from Long Pond, possesses absolutely no advantage whatever over the smaller one, of bringing it from Charles River; and of course that the expenditure of $436,000, which the larger is estimated to cost

more than the smaller, is a sheer waste of so much public money, for which the public derive no benefit whatever.

Hitherto these schemes have been compared only in a pecuniary point of view. But there are some other considerations worthy of notice.

As has been before stated, the Charles River scheme contemplates conveying the water in *iron pipes*. Now I believe nothing is hazarded in saying, that in the opinion of all sound engineers, this is esteemed to be the very best method of conveyance, whether we consider its effect upon the water, or its freedom from liability to decay or accidental failure. Its strength, capacity of resistance inside and outside, its capacity of conveyance, are all well known, and can be calculated and relied upon with entire safety.

The aqueduct from Long Pond is of a different character. It is proposed to be of brick — just the length of one brick in thickness — supported by no exterior masonry whatever. Now in this construction there is novelty, so far as my inquiries have extended. I can find no example, where a structure so *frail* and *unsubstantial* has been relied upon, to perform so important service; and for myself, I hope I shall never see it relied upon. If the Long Pond scheme is to be executed, let it be done on a plan less liable to failure, less liable to perpetual patching and repairing, than this project will certainly require.

The structure recommended by the comissioners of 1844, is even more frail than that of 1837. The commissioners of 1837 recommended that the brick masonry should be surrounded with a layer of puddle, 6 inches thick; which appears to be dispensed with by those of 1844. Puddle, I take to be a kind of mortar made of clay and gravel, or small stones, which, when hardened, would give adhesion and support to the masonry. By the following extract it will be seen what the commissioners thought of the construction *with*

puddle; — how much more pertinent will they appear, when applied to one *without*. They say (page 37), "We have no doubt but a conduit may be constructed from Long Pond, to Corey's hill, which shall be as much beyond the reach of interruption in its operation, as any work of human art can be beyond the reach of accident. *We cannot pretend, however, that the cost given in our estimate, is sufficient to produce a work of this permanent character.*" It seems to be a waste of words to attempt to establish the insecurity of this structure, after such a concession by the commissioners.

But even at the best, a structure like this, if executed in the most substantial manner, like the Croton works, is much less secure than one of iron pipes. It is next to impossible to secure a solid bed upon mere gravel embankments. Liability to failure is greater in the *same distance;* while its greater length — five times greater length — renders its liability to failure five times as great. What, then, can justify its adoption? I know of nothing.

One element remains to be considered, which, in the minds of some, may have weight in favor of Long Pond, — I refer to the hazard of failure, on the part of the engines, to perform the work assigned them. This was the leading reason why the commissioners of 1837 rejected Charles River, as may be seen by referring to pages 30 and 31 of their report; and on that account it is worthy of more consideration than I should otherwise deem it.

The commissioners themselves say, "the chance of failure must be very small." Let us see how small, if we can. The estimate provides for *two* complete engines, pumps, and buildings, *either one* of which will do *all* the required work, by operating 20 hours per day. These constitute the whole of the machinery, the uncertain operation of which we are now considering. These engines, pumps, and buildings, may be so separated from each other, as to be out of danger, the

one from the other, of injury from fire or explosion. Nothing, humanly speaking, but a convulsion of nature, would injure and render inoperative both these buildings, and both sets of apparatus, at the same time; and such a convulsion would be as likely to destroy the city, and remove all necessity of a supply, as to destroy both sets of apparatus, and thus render a supply impossible.

On such a point as this, the opinions of practical men are of great value; — men who make and work steam-engines, and whose daily bread depends upon the regularity and certainty with which they do their work. We have many mechanics in the city so circumstanced, who will satisfy any inquiry as to the reliance that may be placed upon the doings of such engines. From the very best practical authority, I believe it might be made to appear, that if there were but *one* engine, *one* pump, and *one* house, we need not, in ordinary cases, feel much concern but that it could be kept in complete working order till the parts should be worn out, having one-sixth of the time allowed for examination, and making repairs; — but having two such sets complete, it would be entirely idle to fear their giving away both at once.

A few words more on this point. No one of any observation can be ignorant of the course of scientific discovery, in relation to the steam-engine and the means of working it, during the seven years last past, since this report was made. Great improvements are well known to have been made, and are still continually being made; so that we all know that the steam-engine is worked every successive year with more economy than during the preceding; and that the results of its operation may be calculated and be relied upon, with more confidence and certainty every successive day. So that whatever "very small" chance of failure may have been deemed to attach to it seven years ago, has been constantly diminishing ever since; and, so far as can be seen, will continue to diminish for ever.

And what lesson does experience teach on this matter? London is supplied with water raised by steam, except a portion of that supplied by the New River Company. Seven of the eight companies depend entirely on steam, and the eighth partly. There may have been failures, probably there are still, but I do not remember ever hearing of one. If they have occurred, they seem not to have been of importance enough to be noticed.

The waters of the Schuylkill are pumped up into a reservoir, for the supply of Philadelphia, not indeed by steam, but by water power. But I would appeal to the judgment of good practical engineers to say, whether the supply of Philadelphia, by their present water-works, is not liable to interruption from breaches in the dam, from freshets, and other causes, in a far greater degree than would be the supply of Boston, depending upon the engines under consideration; and yet we hear of no inconvenience arising from the uncertain operation of her machinery.

I cannot, therefore, resist the conclusion, that all fears lest the machinery provided should be incapable of performing *constantly* the work assigned them, are entirely groundless, and idle. Neither in theory nor in practice can we find the slightest ground of apprehension.

Thus far, in considering the subject of supplying the reservoir at Corey's Hill from Charles River, I have taken the plan as laid down by the commissioners of 1837, without alteration. This plan contemplated placing the engines at Watertown, and forcing the water through a pipe, $3\frac{1}{4}$ miles long, to the reservoir, elevated 117 feet (see page 71). To effect this, it is estimated that the engine must work under a pressure equal to a head of 150 feet, on account of the friction of the water passing through so long a pipe. Here, then, is a loss of over 25 per cent. power, which might be saved in the proportion in which the distance could be diminished, or

the length of the pipe shortened. It then becomes a question for an engineer to settle, whether it would not be expedient to bring the water down in such a structure as is contemplated for the Long Pond works, to a point on Charles River, in Brighton or Brookline, much nearer to Corey's Hill than the dam at Watertown. If the pipe could be shortened in this manner, the engines could furnish proportionably more water, or furnish the required quantity by working shorter time.

In this way, I suppose it to be practicable to save $\frac{1}{8}$ or $\frac{1}{2}$ the loss of power, or in other words, to increase to a like extent the product of the work of the engines, without much, if any, addition to the cost; though this could only be determined by further inquiries. Additional reasons, of no small weight, for changing the location of the engines as proposed, would be found in the increased facility in furnishing fuel. At Watertown the fuel must be transported by teams; whereas at the points on the River now suggested, the fuel could be delivered from vessels in the immediate neighborhood of the engine houses. A saving of 25 to 37½ cents per ton would thus be saved; and as coal will be an article of perpetual demand, a saving to this small amount on every ton, becomes an important item in deciding upon a plan.

Thus far I have limited my remarks to the delivery of water into the reservoir on Corey's Hill; both plans, as set forth by the commissioners, contemplating the same reservoir. I have, if I do not deceive myself, made out a clear case, and shown that in every important respect in which the different sources admit of comparison, that of obtaining water from Charles River has a decided and obvious preference.

If the water come from Long Pond, I know of no better plan than that of the commissioners, which contemplates the

delivery of the water on the top of Corey's Hill. But if water should be brought from Charles River, there are several points to be attended to, before I should think it advisable to adopt the plan of the commissioners, as they have laid it down. All these points have an economical bearing, without in the least impairing the efficiency and usefulness of the works; but as they have not received the attention of any engineer, that I know of, it is impossible for me to estimate with any accuracy, the saving that might be effected. It will, however, be very obvious, that if the alterations I am about to suggest, or any of them, shall be found on a more minute and scientific examination to be practicable, a great saving will result from their adoption. What I have therefore now to say, must be considered as suggestive, merely, and requiring to be further investigated by competent persons.

The surface of the city of Boston is very uneven — that of few cities more so. While, therefore, the necessities of some of the inhabitants will require the water to be delivered at an elevation of about 100 feet above tide-water, the great mass of the citizens can be supplied at an elevation very much less. Mr. Eddy in his report of 1836, states that 4-5ths of the city lie below a horizontal line, 20 feet above tide-water; and of course that 4-5ths of the inhabitants do not require the water to be delivered at a much higher point. Whether this statement be entirely accurate, I do not know; but there does not appear to be any reason to doubt that it is nearly correct. Taking it to be so, if the whole supply of the city be delivered at an elevation of 100 feet, and 4-5ths of it descend in the pipes 70 feet before it be used, (delivering it at an elevation of 30 feet above tide-water,) nothing can be clearer than that 4-5ths of the water is delivered at a point 70 feet higher than is necessary; and if that water has first been raised by pumps, then 4-5ths of it has been raised 70 feet higher than it need to have been.

Let us suppose, then, that the supplying of the city be divided, as proposed by Mr. Eddy, into *two* services, the *high* and the *low;* and for the sake of being on the safe side, let us suppose that the high service be taken to supply 1-5th of the inhabitants, delivering the water at about 100 feet elevation, while the low service is taken to supply the remaining 4-5ths, delivering the water at half the elevation of the former, or 50 feet. On this supposition, the engines which we have computed to be able to deliver $2\frac{1}{2}$ millions gallons each into the reservoir, by working 20 hours, will be required to deliver only $\frac{1}{2}$ a million into the reservoir proposed, while the other 2 millions may be delivered into another reservoir, only half as high. The one on the top of Corey's Hill, at an elevation of 117 feet, the other, (say for the present) on its side, at an elevation of little less than 60 feet. It will be seen at once that this plan would greatly relieve the labor of the engines, or greatly increase the quantity they could furnish. Each engine, instead of being able to supply $2\frac{1}{2}$ millions gallons in 20 hours, would throw $\frac{1}{2}$ a million into the upper, and 4 millions into the lower reservoir — making both together 9 millions daily; or if worked 24 hours, they would each throw $\frac{1}{2}$ a million gallons into the upper, and 5 millions into the lower reservoir, — making both together 11 millions daily. In either case, they would quickly exhaust Long Pond, and suck it dry, if they were allowed to draw from it. But if so much water be not wanted, as of course it would not be, then the saving might be obtained either by constructing engines of less power, or by working them during fewer hours.

In this connexion it is pertinent to remark, that the extent of the high service is limited; nothing can be added to it hereafter. It is also now about as densely populated as it can ever be — very little land within it remaining vacant. Hence when its wants are once adequately supplied, they are forever supplied. Whatever new wants, therefore, which the

change of habits and increase of the city may hereafter develop, will be entirely in the limits of the low service, and can be provided for at a much less expense than in the high service. So that if in carrying the present suggestion out to its consequences, the present saving should appear to be small, still it may be good policy to adopt it, on account of its future economy.

We see at once that a great saving in the work of the engines, and consequent consumption of fuel, is effected by this division into high and low service. And it is to be borne in mind, that a saving of $1000 in the current expenses of the work, relieves $20,000 in the estimated cost.

There are, however, some additional expenses to be incurred by adopting this plan. For instance, two reservoirs instead of one on Corey's Hill. As however the estimates of the commissioners of 1837, make provision for a division of their one into two distinct parts, and the two that are proposed need be no larger than their one, I suppose both may be constructed without increasing much if any the amount of their estimate.

Two mains must be constructed from Corey's Hill to Boston, instead of one. This will be an increase of expense. But as the two are to do only the service of the one estimated, the expense need not be nearly double the estimates for that one.

So in Boston, two reservoirs will be necessary. But the one on Beacon Hill for the high service, where land is dear and difficult to be obtained, may be a very small one; while the large one for the low service may be located where land is comparatively cheap; or it may be placed on the Common, where the land will cost nothing. I suppose the frog pond is nearly or quite high enough; if not, the hill by its side, and the north-easterly corner are clearly so. So that I conceive the provision in the estimate for a large reservoir on Beacon Hill and a small one on Fort Hill, will require but little if any additions, to construct those now suggested.

The high service is divided into three distinct districts; — of course these districts must be connected, and it will require additional mains, at *perhaps* extra cost, from Beacon Hill to Fort Hill and Copp's Hill. I say *perhaps*, because if it shall be found best, these mains may supply the streets in the limits of the low service, through which they pass, and thus relieve the lower service from an equal extent of pipe.

No other item of expense occurs to me as resulting from this suggestion; and it appears to me entirely safe to limit the additional amount to the cost of the additional mains from Corey's Hill to Boston, and *perhaps* from Beacon to Fort and Copp's Hills. All these matters, however, require the investigation of competent engineers.

Now what are the objections to such a division into high and low service? There can be no question of its economy; and there can be as little that it does not impair the utility of the works. We *know* that it is *practicable;* for it is adopted by several of the London Water Companies. The New River Company, which supplies a much larger district than any other, receives its water into a reservoir 84 feet above the Thames; but for its high service, it raises water by pumping into a reservoir 60 feet higher. It also has a powerful pumping apparatus to raise water from the Thames; but as this is provided for emergencies, it is seldom operated.

The West Middlesex Water works has two large reservoirs, one, 122 feet above low tide water, and the other, 188 feet above same level. These supply two districts at different elevations.

The Grand Junction Water Company has *three* reservoirs supplied by their main pumps from the river. One is at an elevation of 92 feet, the second 86 feet, and the third 72 feet, above high water in the Thames. These all supply services at different elevations; but as none of them are sufficiently high for some customers, the company resorts to another engine to raise water from the second reservoir, 61 feet higher, for the purpose of supplying them.

The Lambeth Company, on the south side of the Thames, also has two reservoirs at different elevations to supply distinct services.

We see, therefore, that there is no novelty in the project. It is practicable, and it is in practice; and it would be difficult to name a city where such a plan would offer greater advantages than in Boston, where the surface is so very uneven.

There is another alteration in the plan of the commissioners, which I deem worthy of suggestion and examination; that is, to dispense with all reservoirs in the city. Corey's Hill is little less than 4 miles distant from the State House, the centre of the highest district of the high service. For the present I wish to regard the high service only. The highest point of Fort Hill is 36 feet lower than the floor of the State House, and Copp's Hill 46 feet lower. There can be no doubt then, I think, that if the high service on Beacon Hill can be supplied without a reservoir in the city, the greater head under which the water will be delivered in the other districts around Fort and Copp's Hill, will more than compensate for the additional distance. The difficulty, therefore, will lie entirely in supplying the highest and nearest district, the centre of which will be little less than, and the extreme point no more than, 4 miles distant from the reservoir. The head will be about 24 feet, or a descent of 6 feet to the mile. It may require a larger pipe to perform the service satisfactorily without a reservoir than with; but the question is, may it not be very well done without one, and with little additional expense in pipe?

What has been done, can be done. The Boston Aqueduct Company delivers water undoubtedly more than 5 miles distant from their head, or more than one mile further than now contemplated. It is true, I suppose, that this Company delivers water at their extreme points under a greater head than is now proposed, but it may be well questioned, whether

the smallness of their pipes, and the crooked course in which they are laid, are not full equivalents for all the extra head they possess.

The West Middlesex Works, in London, distribute water, at one or more points, 10 miles distant from the point where they take it from the river by machinery. Under what circumstances this is done, I have not the means of knowing.

It seems to me, therefore, that there is good ground to believe that, with a main from the reservoir a little larger than would otherwise be provided, the high service might be performed without a reservoir on Beacon Hill. If it be however a doubtful case, where would result the harm of making the experiment? A reservoir could be built 5 or 10 years hence as cheaply as now; and no derangement of general plan, or loss of 50 feet of pipe, need accrue. If, as I think probable, the inhabitants of these districts could be well served without the reservoir, there can be no good reason for constructing one; if not, then let it be constructed when its necessity is made apparent.

Now as to the low service a much clearer case can be made out. The reservoir which we have supposed placed on side of Corey's Hill at a height of 60 feet, could, and should, be brought nearer the city; — say to the high lands near the ship-yard, at west end of the Mill Dam. A reservoir there 50 feet above high water, could probably be supplied by the engines at about the same cost as one 60 feet high on Corey's Hill, nearer to the engines. The distance of this location from the City Hall cannot be far from $2\frac{1}{2}$ miles; — rather less than over, I should think. The distance of the distributing reservoir of the Croton Works is 3 miles from City Hall in New York; — or $\frac{1}{2}$ a mile at least further than the proposed one. The distance of Fair Mount reservoir from the central portion of the water district of Philadelphia is, I suppose, about 3 miles, or $\frac{1}{2}$ a mile further than the proposed one. In both these cases the head, it is true, is greater, but the dis-

tricts supplied are also much greater; and it would seem to be practicable to counterbalance this advantage, certainly to a great extent, by an increased size of pipe.

One other alteration remains to be suggested, and I have done. That is to locate the reservoirs in the city and dispense with those in the country.

In 1825, Mr. Treadwell made estimates for supplying the city with water from Charles River. His plan was to have reservoirs in the city, to bring the water down from Watertown in covered conduits to the Mill Dam, and to use the water power of that dam to fill the reservoirs. If the reservoirs in the country should be dispensed with, then probably it would be best to construct a small reservoir on Beacon street for the high service, and a larger one on the Common, or somewhere else, having the proper elevation, for the low service; to fill these by steam engines located somewhere on or near the westerly end of the Mill Dam; and to bring the water down to that point in structures (one or more) like that contemplated from Long Pond. This will be to adopt, in its most essential features, Mr. Treadwell's original plan; a plan which every candid examiner must allow to possess many advantages, and the estimates and calculations of which had the concurrent scrutiny and approval of Mr. Treadwell and Mr. David Moody. This plan was the leading one in the first Report on the subject ever made to the City government; and in my humble judgment, in its general features it is the best.

If, however, it should be deemed best to adopt this suggestion, it would be found to be all but necessary to adopt the division into high and low service, on account of the difficulty, or impossibility, of obtaining a reservoir near the State House, sufficiently large for both services. The distributing reservoir of the Croton works covers over 4 acres; and the receiving one is much larger still. The reservoirs at Fair Mount have

been enlarged from time to time, and now cover about 6 acres. Though the present wants of Boston do not require reservoirs so extensive, yet by the time the city shall require 5,000,000 gallons, per day, it is not obvious why reservoirs, as extensive as those at Fair Mount, will not be desirable. I will not be guilty of the mockery of asking where 6 acres of land can be obtained in the neighborhood of the State House; —I should be glad to learn where there is one.

In these remarks I have not noticed Spot Pond as a source, because the quantity of water is so small, or at best so doubtful, that it does not offer any inducements *for the city* to resort to it. For a private company it might answer; though even for them, I do not see any advantage it possesses over Charles River. Besides, that source has, I think, been duly presented to the public. Those interested in it have not been unmindful of its claims, and have not been negligent in improving opportunities, to make them known and to press them upon public attention; so that it has become a grave question with me, whether the decisive vote given for the Long Pond scheme, was not rather the result of impatience of the Spot Pond one, than of any conviction that Long Pond was the best source. In fact, the mass of voters knew only of these two; — a third was not thought of.

I have now done with my remarks on this subject. I have shown that the reservoir at Corey's Hill may be supplied with water from Charles River,— water as good as the best from abroad,— at a saving of near HALF A MILLION DOLLARS over the plan of supplying from Long Pond.

I have also suggested alterations, some of which, I cannot doubt would be improvements, in the location of the various parts of the works; by the adoption of which there would result additional substantial savings. I have also suggested a division of the service into *high* and *low;* by which great expense in raising water would be avoided. None of these

suggestions go to impair the usefulness or efficiency of the works. They are thrown out for consideration only; and, if deemed important, should undergo the examination and scrutiny of competent engineers. I have not the requisite knowledge or leisure to go into an examination of them. In making them, however, I have had a constant eye to FACTS. I have suggested nothing, and recommended nothing, which is not elsewhere in *actual practice;* and thus comes recommended to us by the test of experience, — a great point in matters of this kind.

The City government is instructed, by a vote almost, if not quite, without parallel for unanimity, on a matter of this kind, to adopt a scheme at variance with the scope of these remarks, and of course at variance with the most mature and deliberate conclusions of my own judgment. Many of the members have declared their concurrence in the public sentiment, and their intention to carry out the public will, as already manifested.

If those into whose hands these remarks shall come, and especially those who VOTED FOR closing the question by adopting Long Pond, shall see any thing in them to induce a doubt of the wisdom of their vote; if they should feel desirous that the plans and suggestions here made should receive the attenof the City government, and be investigated by competent engineers — all of which could be done in two or three months, as few, if any, new surveys will be required,— then they ought to MANIFEST their desires to the city government, in the way of PETITION. This will justify the city government in taking the requisite steps; and justify it in exactly the proportion that such a disposition shall become general and manifest.

NOTE A.—Page 7.

As this point, regarding the quality of the water, is an important one; and as I find some impressions unfavorable to the water of Charles River are common in the community, which impressions were derived from the Report of Mr. Loammi Baldwin, in 1834; I will endeavor here to do that document some measure of justice.

Of all the commissioners who have made reports to the city government on the subject of supplying the city with water, Mr. Loammi Baldwin is the only one who has made remarks decidedly to the prejudice of Charles River. His account of this water, as derived from others, and not from his own observation, is contained on page 42 of his Report. He says it is "found to be unfit for the finer kind (of paper) on account of its having a dark tinge, usual in bog or ditch water," and that on this account resort was had to springs. "The Waltham factories carry on an extensive bleaching operation, and sometimes employ the river water, but it often gives a shade of reddish tint to the goods, and spring water is used for rinsing."

Now, without at all questioning these facts, I should be glad to learn *where* nice bleaching is done, and *where* fine paper is made, without spring water.* These are two of the most delicate operations, so far as shade or color is concerned, in the whole circle of the arts; and with any thing short of the *most pure* water, they will be more or less imperfectly done. Of bleacheries I know but little; but of paper mills I know something from experience. And whoever, in this part of the country, would carry on paper-making, must have spring water, or he must in some way purify the stream water; if not, he must content himself with the manufacture of inferior kinds. Where spring water cannot be had, mills often run upon fine paper, at the season when stream water is clear, and upon coarse paper when it is discolored. There is no reason to doubt but that the necessity of resorting to spring water for making fine paper, at the outlet of Long Pond, would be quite as pressing (probably more so, according to Dr. Jackson's analysis) as at any point on Charles River.

Again, Mr. Baldwin says, "The river water at times is much clearer than at others, [so is pond and all other water], and the discoloration is probably much increased, of late years, in consequence of the extensive but shallow flowage over meadows and swamp land, caused by the upper dam of the

* See John Clark's Letter in Appendix, in regard to Bleachery at Lowell.

Waltham factories having been raised." Now it seems to me very unfortunate, that at the very time while Mr. Baldwin was imbibing an impression that the waters of the Charles River had obtained an objectionable discoloration from the cause named, Dr. Jackson was analysing them, and pronounced them to be "clear, transparent, *colorless.*" So that if raising the dam did have the effect stated, (as is very probable), that effect, had ceased at the time Mr. Baldwin wrote;—much less is it worthy of notice now, twelve years after.

I cannot forbear, however, to commend this quotation to the special attention and consideration of those who are in favor of Long Pond; as they may here see a little what the effect may be of "the extensive but shallow flowage over meadows and swamp lands," which their scheme contemplates; which meadows and swamp lands have not had the advantage of a fifteen years' soaking.

As copies of Mr. Baldwin's Report are scarce, I shall notice some further facts derived from it.

Mr. Baldwin sent various specimens of water to Dr. Jackson, and he analysed nine of them. Dr. Jackson says, "the bottles were all marked with the letters of the alphabet, and their examination was taken up in the same regular order. The sources from which the water was obtained are to me unknown; thus I am able to furnish you with an account of their several merits, without being liable to imputation of bias in my judgment."

The bottles were, A. Spot Pond, B. Waltham Pond, C. Sandy Pond, D. Baptist Pond, E. Ponkapog Pond, F. Charles River, G. Massapog Pond, H. Long Pond, I. Farm Pond. The general results of this analysis, so far as they affect the waters of Charles River and Long Pond, have been already given; but there are three sentences appended, which I beg leave to quote. "From the foregoing researches, it will appear that the water in bottles A, C, D, E, F, G, H, and I, is sufficiently pure for the ordinary uses of life. B. is too much charged with vegetable matter to be desirable. C, D, F, (Charles River), G, and I, (OMITTING H, OR LONG POND), *are preferable*, and *nearly pure;* the quantity of vegetable matter contained being extremely minute, sensible only to delicate tests." This is clear and explicit language.

But this analysis of the waters of Long Pond, and of Charles River, was not satisfactory to Mr. Baldwin. There is every reason to believe, and none to doubt, (that I am aware of,) that his predilections (as were Mr. J. F. Baldwin's, in 1837) were strongly in favor of a source sufficiently elevated to deliver the water over the city, without the intervention of machinery; and I suppose he would have thought no sum of money misspent, that should be necessary to accomplish that object. It was important, therefore, that the elevated or high water should compare favorably with the low water; at least, that it should not be, plainly and beyond controversy, inferior. He, therefore, sent other specimens of both the Long Pond and Charles River waters to Dr. Jackson, for a new trial. This second specimen from Long Pond was found free from color and animalculæ. Mr. Baldwin says, "the first specimen was taken from the south end of the pond, and was not so favorable a sample as that subsequently obtained at the outlet, and of which the analysis is more satisfactory." Here it is well *particularly* to note that the first specimen, with a "tint of brown" and with animalculæ, was obtained from the *south* end of the pond; and the second specimen, without color and animalculæ, was obtained at the outlet, at the *north* end of the pond. Now, it is surely pertinent to ask, why was not the first specimen a *fair*, if not a "favorable," sample; and why was not the analysis of one as satisfactory as that of the other? We have

no evidence or intimation that they are not both correct. Since the water for the use of the city is to be taken from the pond, if at all, at a point where it is *stagnant*, and far south of the outlet, if not from precisely the south end, where the animalculæ did exist, and where the "tint of brown" was certainly found, and in no manner from the outlet, where they were not found—it seems to me all but certain that the first specimen was the *fair* one of the water we are to get, and that its analysis should be deemed entirely satisfactory, though it developed food as well as drink.

So of Charles River water; the first specimen, he says, "was taken by the falls in Watertown." Dr. Jackson, writing to Mr. Baldwin, says, this specimen "was regarded as an unfair one, and, on that account, I obtained, through your kindness, a fresh supply, free from all objections as to the locality from whence it was taken." Now, inasmuch as the supply for the city, if taken at all, is proposed to be taken "by the falls in Watertown," how could the specimen taken from that place be deemed an unfair one? And inasmuch as it is not to be taken from any other point or locality on the river, how can it be safely averred, that a specimen taken from another locality is entirely "free from all objections" on that account? We, who are to use the water, must certainly think that the specimen taken from the point, where we are to take it, is the *fair* one, and that the specimen taken from some other point, not named, is the *unfair* one.

Let us now consider the results of this second analysis of the Charles River. And in the first place, what was Dr. Jackson expected to search for and find, which he had not previously found? Dr. Hobbs of Watertown, in a letter to Mr. Baldwin, stated that Dr. Dana had, on a former occasion, analysed the water and found in it "carbonate of iron and sulphate of lime," neither of which were detected by Dr. Jackson in his first analysis. Being put upon the scent for these ingredients, Dr. Jackson, *by applying peculiar and delicate tests*, found that "the water does contain *a trace* (nothing but a trace) of sulphate of lime." As to the iron, he says, "tested by liquid ammonia for iron, no precipitate took place; but when the vegetable organic matter was incinerated (i. e. burnt or reduced to ashes) and the ashes dissolved in dilute acid, &c., *a trace* (nothing but *a trace* again,) of iron is easily obtained." From this, it appears that the iron is not in the *water*, but in the *vegetable matter* mixed in the water, which probably would be precipitated in a few hours in a reservoir.

Now so far as one of these ingredients is concerned, viz., Sulphate of Lime, all the requirements of my argument are satisfied by the fact that it exists in a much greater degree in the water of Long Pond, than in that of Charles River. Dr. Jackson found only "a trace" of it in Charles River water, and Mr. Hayes did not find even that. But in the water of Long Pond (as also in Spot Pond) Mr. Hayes found, not "a trace" merely, *but a sensible, appreciable proportion, or quantity.* (See Report of 1837, p. 91, 92).

Then again as to iron,—though it is proved that a trace of this ingredient is found in the water of Charles River, it is not proved that it is not in the water of Long Pond, and in the other waters before analysed. The delicate tests applied to this water, by which a trace of this ingredient was detected, were not applied to the others; and all the tests which were applied to the others, failed when applied to this, to detect any trace of this ingredient. And since the Long Pond water is proved by Dr. Jackson's analysis to have fifty per cent. more foreign matter, either vegetable or mineral, than that of Charles River, (pp. 75 and 76), who is authorized to say that that matter is not also charged with iron?

But there is one fact that would lead us to the positive side of this proposition; and, till the contrary be proved, justify us in assuming that both the objectionable ingredients are in the water of Long Pond; as we know one is. In 1841 and in 1843, the water of Concord river was analysed for Caleb Eddy, Esq., (see his historical sketch of Middlesex Canal), by Dr. Jackson, Dr. Webster, Dr. Dana, and Mr. Hayes, and both these ingredients were found in it by them all. But the waters of Concord river are the waters of Long Pond to a great degree. Judge Thatcher says that "pond is the main source of Concord river." Now who is authorized to say that the iron in Concord river is not also in its main source, Long Pond? Nay further, who is authorized to say, that this ingredient in the river is not *all* from Long Pond, and none of it from any other source? We have no evidence to the contrary.

Again, there is some reason to suppose that the water of Long Pond has a "poisonous" (Mr. Baldwin's word) quality, of which Charles River was never suspected. Mr. Baldwin says: "I remember when the locks, &c., of the Middlesex Canal were built; the workmen, obliged to labor in this water (of Concord River), complained that it (the water), made their hands and feet sore, and if a little scratch occurred to their flesh, or the skin torn or bruised away, the water would cause the flesh to fester into a serious wound, and it was often necessary to suspend working in it, that the sore might heal. This character of the water was confirmed to me a few days ago by Mr. Wilson, a master carpenter," &c., quoting Mr. Wilson's words to like effect. Now, whether all this was fancy, or whether it was fact, I will not pretend to judge; but on the ground that what both Mr. Baldwin and Mr. Wilson asserted *of their own knowledge* was true, it is certainly pertinent to inquire, whence the "poisonous" ingredient came? Did it come from Long Pond, "the main source of Concord River"? or, did it come, and *all* of it come, from some other sources? I pause for a reply; and till I get it, I feel constrained to regard Long Pond water as not desirable to wash my hands in, especially if scratched or bruised.

But the existence and discovery of these ingredients, iron and lime, I regard as of no consequence; for they are to be found in nearly all water. Dr. Dana says of the matters found in the water of Concord River, "both the vegetable and mineral matters are common in well water, and in that of ponds or lakes and rivers." This is doubtless entirely correct. As to iron, it is found by Dr. Jackson (see R. H. Eddy's Report, p. 32), in Horn Pond, in Fresh Pond, in Mystic Pond, in Wedge Pond, and in Winter Pond; and in addition by Mr. Hayes, in Punkapog Pond, and by both in Concord River and Charles River. Sulphate of lime is found by Mr. Hayes in Punkapog Pond, in Neponset River, in Spot Pond, and in Long Pond.

As to the fact above stated, that no animalculæ were found in the specimen taken at the outlet of Long Pond, it may be accounted for by the other fact, that at that point the water had become *river* water. At this point "the race-way (or rapids), was twelve feet wide," and the water in brisk motion; to this extent, therefore, it had ceased to be *pond* water, and had become living *river* water. The animalculæ, by plying vigorously their minute tails, and by moving "with great velocity, by starts, through the liquid," were undoubtedly able to escape the sure destruction that awaited them in that race-way.

APPENDIX.

THERE are few questions that can be brought before the mass of a municipal community, on which it is important that they should form correct opinions, of more importance than this of water. And as the details necessary to come to a perfect understanding of its merits, are numerous and complicated, it is of some importance to spread before the community the views of men, who, from any cause, are entitled to have weight attached to their opinions.

The letters and statements, some addressed to myself and some to others, from which the following extracts are made, I conceive to be of a character worthy of attention.

The first is an extract of a letter from Mr. QUINCY, several years the Mayor of this city. Whether we regard the long experience he has had in conducting municipal affairs, or the complete success which uniformly crowned his municipal enterprises, we shall (I apprehend), all agree that his opinions are entitled to great weight, and should inspire great confidence.

The letter was written to H. Weld Fuller, Esq. counsel for some of the remonstrants against the petition of the city of Boston; and it is proper to add, that it was written without ever having seen my pamphlet.

"*Cambridge, Feb.* 5, 1845.

"SIR:—In reply to your favor of the 3d instant, inquiring concerning my views when mayor of Boston, on the subject of introducing water into that city, and whether I should be willing to appear before a Committee of the Legislature, who have it now under consideration, I have the honor to state, that if called before such a Committee I should obey; but I should regret that necessity. Ever since my connexion with the city of Boston, as mayor and inhabitant, has ceased, I have scrupulously avoided any interference with any subject, which affected the interests, the passions, or the parties that have arisen, or now exist in it; and this from principle, as well as inclination.

"Nevertheless, as you, Sir, have pressed it upon me with some earnestness, I do not think myself justified in withholding the views I then entertained, particularly as they depend upon permanent features of nature in the vicinity; and are so inwrought into my judgment that I do not apprehend that any general reasonings would easily efface them.

"During the five years, from 1825 to 1829, inclusive of both, the subject of introducing water into the city of Boston was urgently pressed upon my attention by citizens of great weight and respectability. It became, accordingly, the subject of discussion and commitment in the city council. As mayor and chairman of the committee, the duty of conducting that investigation devolved upon me.

"The result of the inquiries I then made, satisfied my mind on the following points; and although I know they are, some, if not all of them, disputed by men of far more intelligence and scientific knowledge than I can pretend to, yet my mind has never varied, in its opinion, concerning them.

"First, that water ought to be introduced into the city of Boston.

"Second, that this great and all important interest of the city ought never to be placed under the control of one or more private corporations.

"Third, that ponds, such as now exist in our vicinity, ought never to be depended upon as the source of supply.

"Fourth, that a river was the only source on which a supply of that element, so essential to life and comfort, should be allowed to depend.

"Fifth, that the city of Boston was remarkably well situated for the enjoyment of a river supply.

"So entirely was my mind made up on each of these points, that I took the same precaution, which I had previously used, in effecting the improvements at the eastward of Faneuil Hall, now called the City Market, and which was the chief cause of the success of that improvement. I purchased, conditionally, on my own responsibility, as far as possible, all the rights to land and water adjoining the lower falls on Charles and Neponset rivers, to one or both of which I looked for the city supply. And although I could not effect the purchase, even conditionally, of all the rights on either river, I did thus obtain contracts, (which I now have in my possession), terminating at six months from their dates, for a sufficient quantity of land and number of mill and water rights, as would have given the city the command of as much water as was necessary for its object. And I had contemplated to have made my views the subject of a special communication to the city council, had I been again mayor of the city.

"I shall say nothing of the first and second of these points, as unanimity on them now prevails; although, at the period I allude to, the case was very different.

"As to the third, my opinion was, and is, that, considering the certain prospective destinies of Boston, in respect of a great population, ponds, such as exist in our vicinity, Long Pond included, ought never to be depended upon as the source of city supply. The sources of the supply of a pond are, for the most part, unknown. They are generally below the surface of the pond where they originate, and on what circumstances their influx depends, is a matter of conjecture. They may be permanent or may be transitory. The bottom of a pond, also, is not the subject of inspection. Changes may take place in it; a layer of clay may give place to one of sand or gravel, and the water wholly disappear, or sink so low as to become useless, the expenses lost, and the supply of the city cut off. Such events have happened in other countries; and why may they not happen in ours? Every view and possibility connected with this vital interest is worthy of thought and appropriate consideration.

"Again, a pond is the natural reservoir of all the filth in its neighborhood. The *longer* it is, the more subject to become a receptacle of such collections. Now filth, deposited in a pond, remains for the most part in mass; all its obnoxious particles settle or float according to their nature, and remain there forever. Whereas the particles of filth cast into rivers,

are dispersed or carried off, become diluted or corrected, and even made pure, by the action of the running stream.

"As to the fourth point—That a river is the only source of supply on which a city ought to rely, what I have said concerning ponds will suggest to every reflecting mind, by way of contrast, arguments which seem to me conclusive.

"1. The very action of a running stream is healthful and purifying to the water subjected to it.

"2. The sources of its water may be seen, or known. It comes down from the clouds, or from hills, or from mountains. It brings along with its rapid movement pure air, and particles filtrated through channels above human contact and free from impurities derived from human assemblages. It does not come up like the water of ponds, from nobody knows where, nor lay sluggish and stagnating nobody knows how long, steaming up in its bowels or on its surface, effervescing vegetable or animal matter, in every stage of putrefaction and decay.

"3. Its source is subject to no such unforeseen accident to which any pond is liable. Its water depends on the general lay of the land; and nothing but an earthquake, which should raise the valleys into hills and sink the hills into valleys, could affect in any future time a supply from this source.

"As to my fifth point—That Boston is remarkably well situated for a supply of water from a river; the relations of the rivers in its vicinity are so obvious that I should not think it worth my while to make a remark on the subject, did I not understand that an opinion is maintained by very intelligent men that *machinery ought never to be depended upon* to raise it to the requisite height; and that therefore the city must go sixteen or eighteen miles into the interior, notwithstanding the expense, in order to get a head of water overtopping the highest roofs of the city, let the cost to attain it be what it may.

"For myself, I have never thought, nor do I believe, that the objection to raising the water of the rivers in our vicinity by machinery to any required height, was so insurmountable and formidable, as is asserted. Philadelphia, and, I believe, Baltimore, have resorted to such means, and are content with them. Why should not Boston find the same means sufficient and satisfactory?

"It is after all a question of expense merely; and in my judgment no expense can be so important as to be decisive against a river and in favor of a pond.

"This objection surmounted, then I repeat Boston is, in my opinion remarkably happily situated for a supply of water from a river, and that both pure and abundant.

"Boston has apparently two rivers in its vicinity from which it can make its selection, the Charles and the Neponset; and such is its peculiar felicity in this respect, that it can avail itself of the waters of both these rivers if necessary." ———.

THE following is a letter addressed to me by Dr. WARE, an eminent and successful physician of this city. I regard his opinion as very valuable on *two* accounts: 1st, it is the opinion of a gentleman, who, by education and taste, is presumed to be familiar with the philosophical and mechanical principles involved in the plan which he approves; 2d, it is the opinion of a gentleman whose profession leads him to form a just appreciation of the value of good pure water, and who would be likely to be sensitive to any causes or occasions of impurity.

Boston, Jan. 26, 1845.

DEAR SIR:—I am much obliged to you for your pamphlet on the supply of the city with water. Ever since Mr. Treadwell's original examination of the subject, I have entertained the same opinion which you express, that Charles River was the appropriate source; and I have never seen any statement since, which has in any degree served to alter it. The objection derived from the impurities which are mingled with the water at Waltham does not seem to me a sufficient one, even were there no means of obviating it; and I suspect there would be quite as much of foreign material in the water of Long Pond, especially if it were flooded over its present margin. I do not know that you propose any action on this subject, but I supposed it might be a satisfaction to you to know that others agreed with you, and appreciated what appear to me the very satisfactory statements which your pamphlet contains.

I am, very sincerely, yours

JOHN WARE.

THE next is the substance of a letter received by me from JOHN CLARK, Esq. of Lowell. Mr. C. is a native of Waltham, and was brought up there near the Charles River. He is extensively known in this city, having resided here several years; and where known, his opinion will doubtless receive all the weight that any friend would claim for it. He has for several years past been the agent of one of the Lowell Factories, and is also, I believe, one of the Aldermen of that city.

Lowell, Feb. 8, 1845.

DEAR SIR: Your favor of the 25th January came duly to hand, with the accompanying pamphlet; for which you will accept my thanks. I have delayed answering, until I could make some inquiries; which being made, my own impressions of Charles River water are confirmed. These impressions are, that the water is uncommonly pure for River water—purer than the Schuylkill, or the Croton, but not so pure as the water of the Merrimack, which is absolutely the purest river water known in these parts, being almost, or quite, entirely free from vegetable matter, of which Charles River contains a small portion, though much less than Concord River. Yet, notwithstanding the extreme purity of Merrimack River water, the Lowell Bleachery was established at the distance of a mile from the River, in order to avail itself of spring water for the last washings. The fact therefore that the Waltham Bleachery uses spring water, is no argument whatever against the purity of the water in their river. My opinion is, that Long Pond water is already largely impregnated with vegetable and other impurities, and that if it be raised so as to flow other meadows, it will necessarily become more so. I think your argument for Charles River water is unanswerable, as opposed to Long Pond. Perhaps Neponset River might be preferable, and I suppose is equally pure, as I believe they flow from the same sources; I am not, however, so familiar with that as with Charles River.

Yours, very truly,

J. CLARK.

Probably no public enterprize was ever preceded by more careful and elaborate attention to the details of its construction, and to the estimates of its cost, than the Croton Aqueduct. During the five years preceding the actual commencement of that work, engineer after engineer, singly and together, were devising plans and arranging details for the execution of it. On looking over the history of its progress, both in plan and execution, one is astonished at the immense amount of labor bestowed upon the matter in every stage. There seems to have been no lack of prudence or caution in having all doubtful points reduced to matter of certainty, as far at least as certainty could be attained, before the City was committed to the project. The whole aqueduct was divided into sections, and the work to be done in each section was closely scrutinized and estimated, before proposals for its execution were solicited.

In February, 1837, proposals were solicited for 23 sections or 8½ miles; proposals were received for all, but so far exceeding the estimates, that only ten were accepted, and these at a price considerably exceeding the estimates. I believe it is a fact, that from one end to the other, not a single section was ever let at the sum estimated.

I am aware that an opinion prevails, that much money has been *squandered*, or spent uselessly, upon the Croton works. It may be that *some* has been; but I am not prepared to admit that a great amount has been. In the 1st place, New York selected her source much more *prudently* than we shall, *if we go to Long Pond*. She took the *nearest* accessible water that was deemed adequate to furnish a supply. I suppose, also, that the aqueduct was, in general, as cheap a structure as could be, or ought to be, relied upon to do the service. I do not know but that the sum paid in way of damages was as reasonable as ought to have been expected. We know the city complains; but we know, also, that questions of this kind have two sides, and we have seen but one. Not a rod of land could be had, by voluntary purchase, at any price. It is true, that a freshet carried off the Croton dam just when it was finished;—occasioning an immense loss. This came to pass, because the dam was constructed to bear a perpendicular pressure of six feet only on its crown; and the first thing they knew, the water rose to fifteen feet, and, of course, crushed it, or swept it away. So, also, it was intended to cross Harlaem River on a *low* bridge; but the legislature interfered, and a *high* one was constructed. Perhaps these particular cases of expenditure could not have been foreseen; and it is more than probable, that important items in our project cannot now be foreseen. With some exceptions of this kind, I am not prepared to say, that the expenditure on the Croton Works *has been* greater than *ought to have been* anticipated. And I do not see any good ground to expect that we can keep our expenditure nearer to the estimates, if we adopt the Long Pond scheme, than New York did in the execution of her Croton Works.

The subjoined statement is furnished me by E. H. Derby, Esq. It shows how much labor and pains were expended in maturing the project before it was commenced; and how utterly inadequate the provision made was to the execution of the work. In this respect, the statement is full of admonition to all who would try experiments, and adopt a plan that is not recommended by experience. This, and the next statement, should be examined in connection.

"Croton Aqueduct.

"The investigation of the proper sources to supply New York with water commenced in 1799.

"In 1832, Col. De Witt Clinton, an engineer, reported a plan to introduce the Croton, and estimated the expense at $2,500,000.

"In 1833, the State of New York appointed commissioners to examine sources, the means of the city, and report a plan for the introduction of pure water. They employed two distinguished engineers, Canvass White and D. B. Douglass, who reported to the legislature a plan to bring in the Croton, which they stated to be feasible and within the means of the citizens.

"In 1834, the State again appointed commissioners to prepare and present to the common council of New York a plan for an aqueduct, with estimates of cost and income, which, if approved, was to be submitted to the electors.

"These commissioners engaged three engineers, Messrs. Douglass, Martineau and Cartwright, to make several estimates and reports; and in 1835, submitted a plan with minute estimates of the cost, including the Harlem Bridge and distributing pipes, amounting to $5,512,330.71. They also submitted an estimate of income from the aqueduct of $310,516, which the council submitted to the citizens, with the remarks, 'that money could be borrowed at less than 4 per cent; that the rents would exceed the interest, and no tax be required.'

"The vote of the citizens was taken in April, 1835, when 17,330 voted in the affirmative, and 5,963 in the negative.

"On the 4th of January, 1838, after the work was begun and nearly all the contracts let, the commissioners submit a report to the common council, stating that the work will require five years more for completion, and will cost $8,464,033, beside the cost of distribution. They remark: 'The *excess* can only be accounted for by the fact, that the engineers originally employed did not possess the means of testing their calculations by the actual cost of the work under contract, as we have done.'

"The aqueduct was opened for use June 22d, 1842, though it is not yet completed."

The subjoined statement is furnished by Lemuel Shattuck, Esq.

Statement of the payments on account of the Aqueduct, compiled from the Official Documents of New York, in possession of Mr. Shattuck.

	Jan. 1, 1843.	*Jan.* 1, 1844.
Paid Water Commissioners on Contracts, &c. . .	$ 7,900,790.24	$ 8,173,003.74
" Water pipes and laying,	1,804,149.53	2,087,251.87
" Interest to August 1, 1842,	1,577,459.43	1,577,459.43
" Specie to pay interest in 1837–8, . . .	2,831.18	2,831.18
" Water loan expenses,	6,840.81	8,290.13
" Preservation of works during riot, . . .	3,146.56	3,146.56
" Discount on sale of stocks,	647,157.32	647,157.32
Total payments at those periods,	$11,943,371.87	$12,499,140.23

On the 10th Aug, 1844, the water debt was as follows:—

At 5 per cent.	$ 9,285,232	Annual Interest,	$464,261.60
At 7 per cent.	2,000,000	" "	140,000.00
At 6 per cent.	1,062,973	" "	63,778.38
At 4 per cent.	288,693	" "	11,547.72
Total debt	$12,636,898	Annual Interest,	$678,687.70

The interest since Aug. 1842, has been paid by a tax on the city. In 1842, in part, $475,566; in 1843, $665,000; and in 1844, $679,687. These sums amount to $1,820,153, paid by taxes, which, added to the debt last August, make $14,457,051, which the city then had paid, or became liable to pay, on this account. Additions to this debt have since been made, as the works are not yet completed.

The gross income from the water rents for 1844, was		$102,600
From which deduct the annual cost of maintaining the aqueduct from the Croton river to the city, about	$25,000	
Repairs for hydrants, stop-cocks, breaks in water-pipes, tools, &c. about . .	25,000	
Salaries of the "Croton Aqueduct Board" consisting of twenty-six individuals, exclusive of laborers, ...	20,919	
		70,919
Net income from the water rents in 1844,		$31,681

This is equal to six per cent. on a capital of $528,016. There were 8,988 water takers in 1844, which give a net income of $3.52 each.